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Alternative Information Sources on Deaths in Brazil in the Context of the COVID-19 Pandemic

by Everton E. C. Lima, Marcos R. Gonzaga,
Flávio H. M. de A. Freire, and Bernardo L. Queiroz

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INTRODUCTION

Part of the history of vital events compilation in Brazil begins in 1944, when the Federal Bureau of Biostatistics of the National Department of Health published the Biostatistics Yearbook, presenting data on mortality causes for the years 1929 to 1932 for deaths that took place in Brazilian capital cities.[1] In the early 1970s, the Brazilian Institute of Geography and Statistics (IBGE) began to publish mortality data, based on causes of deaths, but not on a regular basis.[2] From 1975 on, mortality data also began to be collected by the Ministry of Health through the Mortality Information System (MIS), which contributed substantially to advances in death information and studies in the country.[3] Thus, since 1976, the country has had two independent sources for compiling death data in the nation, which allows for building population demographic and health indicators.[4] It is important to highlight that a unified nationwide death certificate only occurred in 1975, with the Ministry of Health implementing a single model, and that there were local strategies for collecting and disseminating mortality data since the beginning of the 20th century, as in São Paulo.[5]

The two sources of information on deaths in the country have co-existed, with varying completeness and coverage between the major regions and states. Although the origin of the record is the same (death certificate or declaration issued by a medical doctor), the path taken by the information until it is made available to the user is disparate. The flowchart in Figure 1 shows the path taken by the death certificate from the place of issue until its availability to the user.

1 Jorge, M. H. Prado de Mello et al. 2007. pubmed.ncbi.nlm.nih.gov/17680121/

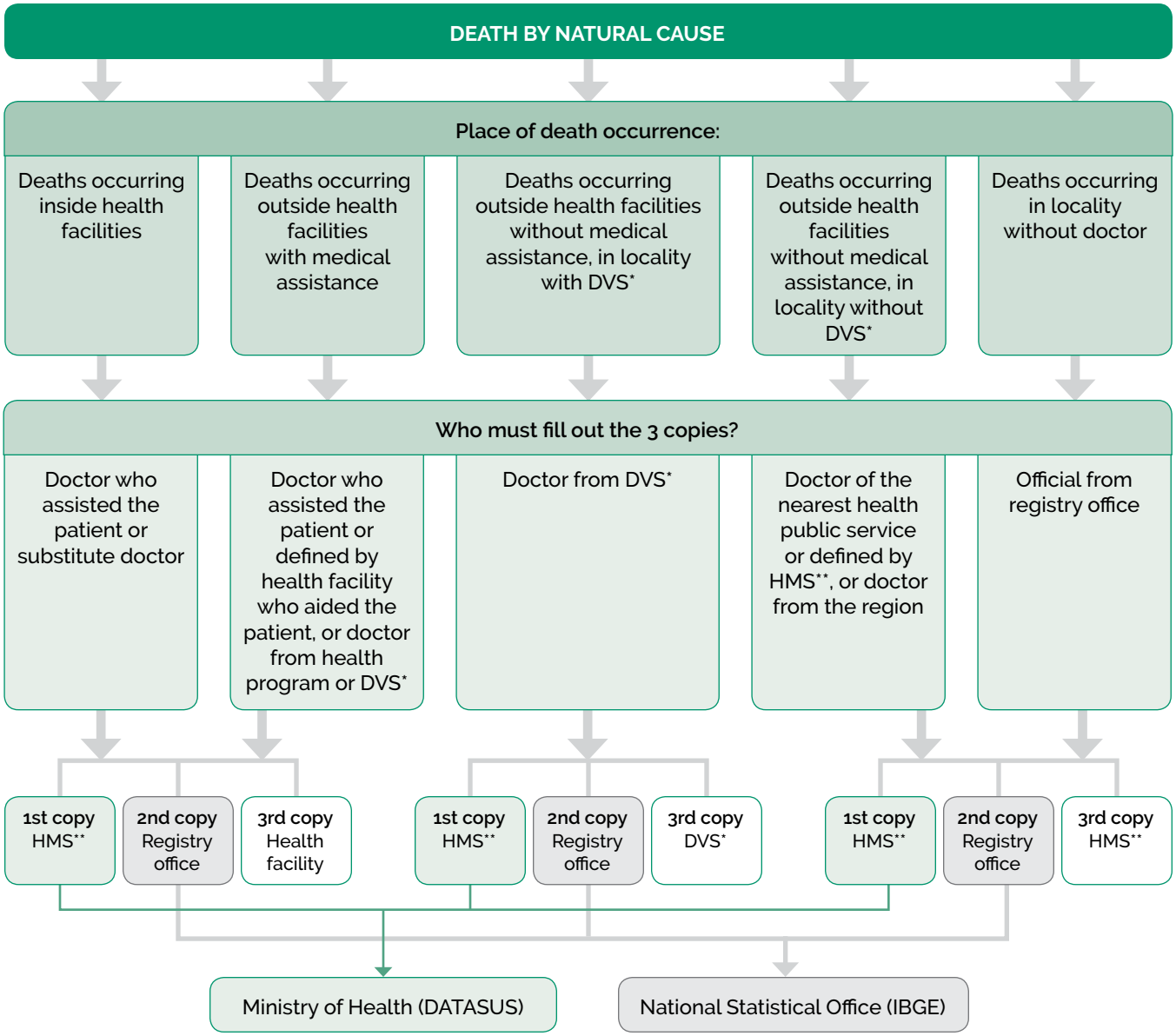
2 Baldijão, M. F. A. 1992. produtos.seade.gov.br/produtos/spp/v06n04/v06n04_04.pdf

3 Jorge, M. H. Prado de Mello et al. 2007.

4 Vasconcelos, A. M. N. 1998. rebep.org.br/revista/article/view/416

5 Waldvogel, B. C. and de Carvalho Ferreira, C. E. 2003. produtos.seade.gov.br/produtos/spp/v17n03-04/v17n03-04_06.pdf

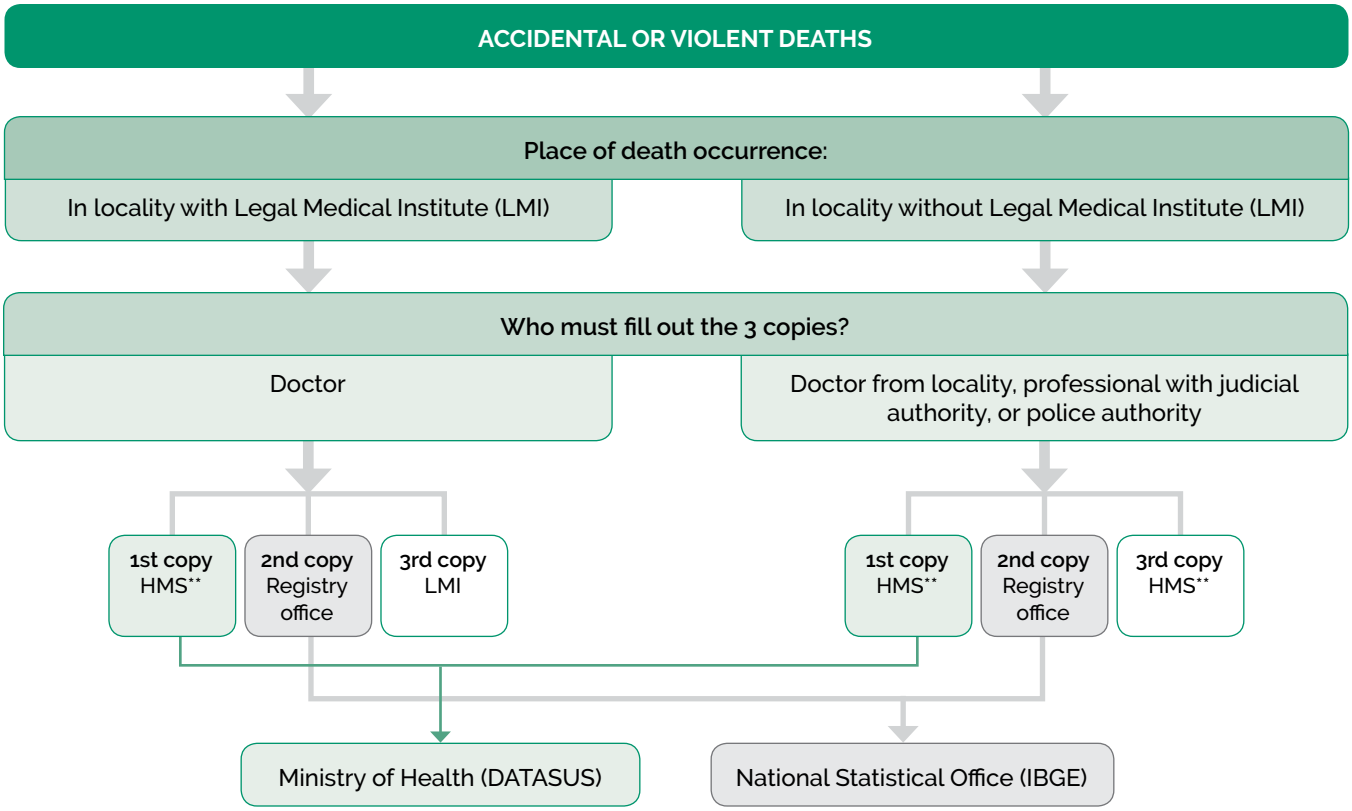
Figure 1: Flow of death certificates in Brazil.



Source: Adapted from the instructions manual for filling out of death form. Ministry of Health. Brasília, 2011

*Death Verification Service; **Health Municipality Secretary

Figure 1: Flow of death certificates in Brazil (continued).



Source: Adapted from the instructions manual for filling out of death form. Ministry of Health. Brasília, 2011

*Death Verification Service; **Health Municipality Secretary

The path taken by accidental and/or violent death is slightly different from other causes of death due to the presence (or not) of the medical facility in the location where the death occurred. In general, a copy of the death certificate is registered with a notary and becomes part of the civil registry, which is compiled and made available by the IBGE. A second copy is filed with the municipal health department, goes to the Ministry of Health, and is made available to the user through the MIS. A third route is through the health establishment, which can be a hospital, legal medical institute, municipal health department, or death verification service. The Ministry of Health compiles the death information, which arrives in a decentralized manner through municipal health departments, while the IBGE centralizes collection through the registry offices. This can be seen as a good Brazilian practice that could be followed by other nations with less developed civil registration systems. More recently, the Ministry of Health has put forward a proposal for electronic death certificates.

Death records systems are made available to the public at the Ministry of Health (DATASUS) and the IBGE. The Ministry of Health database provides death records access online,[6] as does IBGE.[7] The municipal mortality registries contain death information by age and sex, as well as other demographic information regarding birth care, prenatal care, and fertility. DATASUS also contains information on primary and secondary causes of death, in addition to a series of socio-economic data.

In addition to the fact that information goes through different paths until its availability to the user, there are other socio-economic, demographic, and cultural factors with important regional disparities. For example, rural populations, especially in the north and northeast of the country, have lower socio-economic levels that generally do not realize the importance of registration. All of this affects information quality, in coverage and completeness.[8]

Despite the national increase in coverage from both data sources, data is still precarious in some locations, especially in the north and northeast of the country,[9] [10] [11] which also reflects the poor quality of mortality information in certain areas of Brazil. Information gaps in the poorest municipalities show the enormous health inequities in the Brazilian population, also reflecting the lack of access to public health goods and services.[12]

It should be noted that over the past few years, the Ministry of Health has been investing in continuing improvements in the MIS, aimed at reducing the percentage of deaths registered as ill-defined, developing new data collection technologies, and conducting staff training. Improvements in recording information on causes of death occurred through the implementation of a specific project by the ministry with a role in

6 DATASUS. 2020. datasus.saude.gov.br/

7 SIDRA. 2020. sidra.ibge.gov.br/home/pms/brasil

8 Vasconcelos, A. M. N. 1998.

9 Agostinho, C. S. 2009. cedeplar.ufmg.br/publicacoes/teses-e-dissertacoes/teses-demografia/category/130-2009

10 Lima, E. E. C. and Queiroz, B. L. 2014. scielo.br/scielo.php?script=sci_arttext&pid=S0102-311X2014000801721

11 Queiroz, B. L. et al. 2017. scielo.br/scielo.php?pid=S1415-790X2017000500021&script=sci_arttext&tlng=en

12 Kanso, S. Romero et al. 2011. pubmed.ncbi.nlm.nih.gov/21808817/

investigating deaths by ill-defined causes and, in some cases, by verbal autopsy.[13] [14]

In addition to the classic problems related to underreporting of deaths, completeness, poor classification of age at death, and the excessive number of deaths classified as ill-defined,[15] [16] another recurring problem is the time of availability of information. Such data is made available monthly by municipal and state health departments, and currently only information for 2018 is available from both sources.[17] [18] We must ask ourselves how these agencies could provide quick access to information on deaths in times of stress, such as the current COVID-19 pandemic that the country is experiencing.[19] [20]

Given this context, what alternative sources of mortality information and death data classified by infection by the new cause of death (SARS-CoV-2) have emerged in the country to fill this time gap left by official sources of mortality information? This paper will discuss the role of these alternative sources of collecting mortality information in the context of the pandemic. We will explain the history of the official sources of death information, their main quality issues, and finally, give a brief account of alternative information sources.

SOURCES OF VITAL STATISTICS IN BRAZIL WITH A FOCUS ON MORTALITY

Mortality data from the Instituto Brasileiro de Geografia e Estatística

Civil registry statistics are collections of information from official public administrative records that provide elements for demographic studies. These aim to monitor events that change the size or composition of the population over time.[21]

The first *de facto* act related to the future functioning of the civil registry was the prohibition on burying people without a death certificate issued by a "doctor or other practitioner," determined by a law in 1814.[22] [23] In the second half of the 19th century, more decrees were issued that regulated marriages and death records of those who did not profess the Catholic faith. At the beginning of the 1860s, due to the intensification of international migration in the country, decrees were passed that assigned regulation of death records of all those who did not profess the official religion at the time, Catholicism, to the state.[24] [25]

13 França, E. B. et al. 2014. scielo.br/scielo.php?script=sci_abstract&pid=S1415-790X2014000100119&lng=pt&nrm=iso

14 Cunha, C. C. D. et al. 2017. doi.org/10.5123/s1679-49742017000100003

15 Lima, E. E. C. and Queiroz, B. L. 2014.

16 Cunha, C. C. D. et al. 2017.

17 IBGE. 2020a. ces.ibge.gov.br/apresentacao/portarias/200-comite-de-estatisticas-sociais/base-de-dados/1148-estatisticas-do-registro-civil.html

18 DATASUS. 2020.

19 Adjiwanou, V. et al. 2020. doi.org/10.31235/osf.io/4bu3q

20 Rao, C. 2020. who.int/bulletin/volumes/98/5/20-257600/en/

21 Oliveira, L. A. P. and Simões, C. C. D. S. 2005. rebep.org.br/revista/article/view/245

22 Ibid.

23 IBGE. 2020a.

24 Oliveira, L. A. P. and Simões, C. C. D. S. 2005.

25 IBGE. 2020a.

Photo: Mariana Ceratti / World Bank

In 1888, the Civil Registry of Natural Persons underwent changes. The civil registry of individuals was created and statistics on births, deaths, and marriages were no longer the responsibility of the Catholic Church, but were transferred to the General Directorate of Statistics and, therefore, to the Demographic, Moral, and Political Statistics Service of the Ministry of Justice.[26] From that point, the country began to regulate birth, death, and marriage records. It is worth highlighting that death records still lacked breadth throughout the Brazilian territory.[27] Nevertheless, over the course of several periods of Brazilian history, the civil registry underwent numerous modifications through the coordination of various bodies in a diversified process of implementation and consolidation.[28] [29]

First, Decree No. 70210 of 1972 transferred the authority of producing vital statistics to the IBGE and this was reiterated by *Law 6015 of 1973*. This law also established the country's current civil registry system, incorporating the changes introduced by *Law 6140 of 1974* and *Law 6216 of 1975*. The delegation assignment was established by the 1988 Constitution (Article 236), regulated by *Law 8935 of 1994*. These laws transferred the responsibility for processing vital statistics from the Ministry of Justice to the Ministry of Planning.[30] These laws also established standards regarding the civil registration of natural persons, among others. In addition, the decree delegated the task of collecting and processing civil registry statistics to the IBGE, as well as the body's responsibility to provide the necessary forms to civil registry officers. It also stated that these must be sent to the IBGE within the first eight days of January, April, July, and October of each year, reviewing the data on registered births, marriages, and deaths. In the specific case of death records data, these have been regularly collected by this body since 1974.[31]

It is important to note that until 1997, civil registration and the respective certificate were free of charge to people who were proven poor, and according to Law 9.534 of the same year, free civil registration of natural persons was determined for all Brazilians.[32] [33] In addition, the death record was legally supported and, in legal terms, became a precondition for all burials. This data is available to the public through the IBGE Automatic Recovery System.[34]

26 Ibid.

27 Vasconcelos, A. M. N. 1998.

28 Senra, N. 2006. biblioteca.ibge.gov.br/index.php/biblioteca-catalogo?id=282656&view=detalhes

29 Senra, N. 2008. scielo.br/scielo.php?script=sci_arttext&pid=S0104-59702008000200011&lng=pt&tlng=pt

30 IBGE. 2020a.

31 Ibid.

32 Presidência da República. 1997. planalto.gov.br/ccivil_03/leis/l9534.htm

33 Oliveira, L. A. P. D. and Simões, C. C. D. S. 2005.

34 SIDRA. 2020.

Despite all these regulations, the collection of death data still suffers from several difficulties. First, until 1997, legal authorities used to charge for birth and death certificates,[35] which led to an insufficient number of vital event registrations and, in many cases, late birth and death registrations, especially among those of lower socio-economic strata who lived in the poorest areas of the country.[36] Second, the initial official procedure for recording vital events required the presence of two witnesses.[37] Finally, medical information on the causes of death was not available in these records, data collection was scattered, standardization was lacking, and information was incomplete and not dated, which constituted an obstacle to effective planning. This, in turn, prompted the creation of other mortality information systems.

In 2007, Decree 6289 established the national commitment to eliminating underreporting of vital statistics. Among other measures, a task force was created to standardize the records, with the creation of a National Registry Office. In it, a unique identification number was assigned to each civil registry office. In addition, birth, marriage, and death certificate forms were standardized nationally, creating a unique registration number for each. These standards were regulated by the National Council of Justice in provisions 2 and 3, and amended by provision 63/2017.

Mortality data from the Ministry of Health

In parallel with the creation of the death registration system under the care of the IBGE, and due to the lack of information on the causes of death, Law 6.229 was passed in 1975. This set out the creation of the National Epidemiological Surveillance System, which served as a subsystem of mortality information.[38] The Ministry of Health then created an independent system for collecting mortality information, the MIS.[39] [40] Under this system, a single death certificate form was established throughout the country, whose information on causes of death followed the international standard proposed by the World Health Organization. In addition, a standardized flow of data was created, and it was established that its printing, processing, and distribution should be handled at the central level.[41] [42] Also supported by the creation of the Brazilian Centre for Classification of Diseases, the MIS framework was enlarged. The centre worked on training personnel to classify causes of death and raise awareness among health authorities about the relevance of their data.

Another important point was the adoption of a single standardized death certificate form for deaths and fetal deaths, which facilitated standardization of information. Highlighted among the timely changes that occurred with the MIS[43] were the following:

35 Oliveira, L. A. P. D. and Simões, C. C. D. S. 2005.

36 Vasconcelos, A. M. N. 1998.

37 Ministry of Health. 2009. portalarquivos2.saude.gov.br/images/pdf/2015/agosto/14/Declaracao-de-Obito-WEB.pdf

38 Jorge, M. H. Prado de Mello et al. 2007.

39 Ministry of Health MIS. 2020b. opendatasus.saude.gov.br/dataset/casos-nacionais.

40 Vasconcelos, A. M. N. 1998.

41 Ibid.

42 Jorge, M. H. Prado de Mello et al. 2007.

43 Ibid.

- Sequential numbering was used to control issuance, distribution, collection, and retrieval of death certificates.
- A live birth declaration number was used in death certificates for children under 1 year of age, to pair information with data from the Live Birth Information System.
- As a way of collecting information on maternal mortality, specific variables were introduced to identify whether women of childbearing age who died were pregnant at the time of death or had been pregnant within one year of the fatality.
- The government sought to collect important population characteristics, such as race and colour of the deceased, to identify specific social strata.
- A field related to death by external causes was introduced, with a summary description of the event and the source, which allowed such a description.
- The exchange of information from the medical certificate to the conditions and cause of death was a way to remove any idea that the physician was the only one responsible for filling in this field.
- Following recommendations of the 10th International Classification of Diseases (ICD-10) revision, the MIS included a field to facilitate codification of the causes noted on the certificate.

Currently, death certificates are completed in three copies of different colours, with specific flows for deaths occurring in homes and hospitals (Figure 1). The document is filled out by a physician or, if the death is due to unnatural causes, by a coroner.[44]

The Ministry of Health uses a decentralized model, and gathers information on deaths obtained by state health departments. Death certificates are distributed by the ministry to the state health departments, and from there to the municipal health departments. Municipal health departments control death certificate distribution to health facilities, civil registry offices, forensic medicine institutes, and so on.[45]

Also, Administrative Ruling 474 and 20 of 2000 and 2003 mandated the data collection, flow, and frequency of sending death information from municipal health departments to state health departments. Financial resource transfers to municipal health departments were suspended if they failed to supply the health information systems, including the MIS, for two consecutive months. These measures served to consolidate the MIS.[46]

As a means of dissemination, this mortality data is available online, with information on deaths by place of residence and occurrence, sex, age, and causes grouped in ICD-9 chapters for the years 1977 to 1995, and ICD-10 from 1996 until recently. This source collects information on approximately 1 million deaths per year annually.[47] [48]

44 Ministry of Health. 2009.

45 Jorge, M. H. Prado de Mello et al. 2007.

46 Ibid.

47 DATASUS. 2020.

48 Jorge, M. H. Prado de Mello et al. 2007.

PROBLEMS WITH MORTALITY INFORMATION SOURCES

Underreporting of deaths

Mortality estimates are essential for better understanding the demographic dynamics and impacts of the pandemic on diverse populations. However, in Brazil and various other countries around the world, estimating mortality has become a challenge, as the quality of information is generally unsatisfactory.[49] [50] [51] In the case of Brazil, the data obtained from the civil registry system and from the Ministry of Health have limitations. The MIS, organized by the Ministry of Health based on death certificate information, and the civil registry, under the responsibility of the IBGE, contain information collected from Brazilian registries and disseminated by the IBGE.[52]

One potential advantage of the MIS in the pandemic context is the greater amount of information available and the record of the cause of death according to the International Classification of Diseases. However, this data will not be available soon since the process of data dissemination goes through several stages and reviews. The vital statistics system (civil registry) gathers information on live births, marriages, deaths, and stillbirths reported by civil registry offices for individuals, as well as divorces registered by family courts, civil courts, and registry offices, but as noted above, it has limitations.[53]

In both databases, difficulties in the data sources used to estimate mortality are related to incomplete coverage of the death record and errors in the age declaration, both in the death record and in population data.[54] [55] This large data limitation results in highly underestimated calculations of mortality rates in different locations of the country and, consequently, an overestimation of life expectancy at birth.[56] Figure 2 shows male life expectancy at birth estimated and adjusted for underreporting in applying the Bayesian model proposed by Schmertmann and Gonzaga for the year 2010,[57] as well as estimates with no underreporting correction from both data sources: MIS (Ministry of Health) and the civil registry (IBGE).

49 Queiroz, B. L. et al. 2017.

50 Luy, M. 2012. link.springer.com/article/10.1007/s13524-012-0101-4

51 Agostinho, C. S. 2009.

52 These are available for 2018 and 2020 through the Transparency Portal.

53 Mikkelsen, L. et al. 2015. thelancet.com/journals/lancet/article/PIIS0140-6736(15)60171-4/fulltext

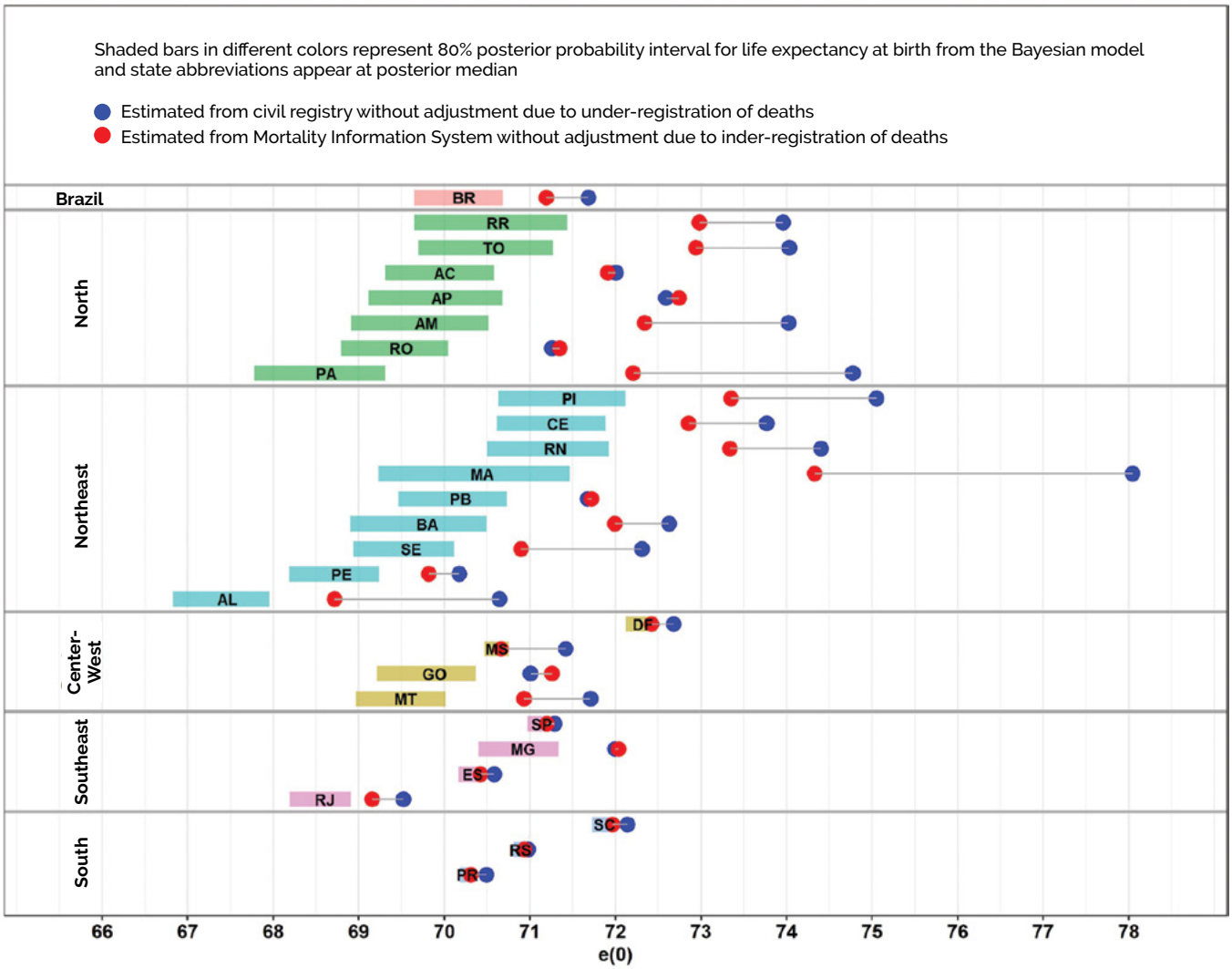
54 UN DESA. 2017.

55 Hill, K. et al. 2009. demographic-research.org/volumes/vol21/9/default.htm

56 Lima, E. E. C. and Queiroz, B. L. 2014.

57 Schmertmann, C. P. and Gonzaga, M. R. 2018. link.springer.com/article/10.1007/s13524-018-0695-2

Figure 2: Male life expectancy at birth by state according to major regions, Brazil (2010).



Source: Ministry of Health (MIS/DATASUS), Civil Registry (IBGE), and Schmertmann and Gonzaga (2018)

Note: BR (Brazil), RO (Rondônia), AC (Acre), AM (Amazonas), RR (Roraima), PA (Pará), AP (Amapá), TO (Tocantins), MA (Maranhão), PI (Piauí), CE (Ceará), RN (Rio Grande do Norte), PB (Paraíba), PE (Pernambuco), AL (Alagoas), SE (Sergipe), BA (Bahia), MG (Minas Gerais), ES (Espírito Santo), RJ (Rio de Janeiro), SP (São Paulo), PR (Paraná), SC (Santa Catarina), RS (Rio Grande do Sul), MS (Mato Grosso do Sul), MT (Mato Grosso), GO (Goiás), and DF (Distrito Federal).

The effect of underreporting deaths is clear from the estimates shown in Figure 2 to the extent that life expectancy at birth, from direct MIS (DATASUS) and civil registry (IBGE) data, which were not corrected for underreporting, provide higher life expectancy at birth for all states, especially in the north and northeast regions of the country. In some states in the south, southeast, and central-west regions, life expectancy estimated without underreporting correction of deaths is similar to those estimated by the Bayesian model (already corrected for underreporting). This shows that, in 2010, coverage of MIS deaths (DATASUS) in these states was already close to 100 percent. The same could not be said for civil registry (IBGE) coverage of deaths. Thus, upon analyzing the results in Figure 2, the considerable difference in coverage of deaths between the two information sources is noteworthy, especially in the state of Maranhão.

A comparative analysis with other estimates[58] shows that in 2010 in several states in the north of the country, life expectancy calculated using MIS data, with no adjustment, would be three years higher on average than when considering potential problems in recording information. To work around these data problems, various methodologies have been developed to measure mortality using direct and/or indirect demographic methods[59] [60] [61] or a combination of these with Bayesian inference.[62] In the case of Brazil, inclusion of a question concerning deaths in households within the last 12 months still stands out. This variable was included in the 1980 sample questionnaire and in the 2010 universal questionnaire, and was expected to be included in the 2021 census. Queiroz and Sawyer analyzed information quality and compared the results with the estimates obtained from DATASUS and the civil registry of 2010. They showed that the underreporting pattern by age is similar between the two sources, but MIS coverage is better.[63]

In an analysis of the two sources of information on deaths from 1990 to 1995, Vasconcelos points out that up to that point, the quality of information on deaths would be related to the intrinsic socio-economic conditions of each state in the country and that for much of the population, MIS data would have been a better quality.[64]

A good practice to highlight, and which is clearly seen in the results of Figure 2, was an initiative by the SEADE Foundation to create a unified base of births and deaths from database relationships originating from the civil registry with databases from the MIS of the state of São Paulo. This initiative represented an important leap in quality in the production of vital statistics in the state of São Paulo.[65]

In the last two decades, the quality of mortality data in Brazil has demonstrated significant progress, but with great regional variability.[66] [67] [68] [69] Queiroz et al. combined a series of demographic methods to assess the quality of death information in Brazil.[70] The results of Lima and Queiroz showed an improvement of mortality information in Brazilian regions between 1980 and 2010.[71] For Brazilian states, there are studies that analyze the evolution of data quality. In particular, Paes[72] and Agostinho[73] studied the quality of mortality data from Brazilian states for the periods 1980 to 1991, 1991 to 2000, and 2000 to 2010, and showed that there were signs of improvement, but still much regional heterogeneity.

58 Queiroz, B. L. et al. 2020. pophealthmetrics.biomedcentral.com/articles/10.1186/s12963-020-00213-4
59 Hill, K. et al. 2009.
60 Murray, C. J. L. et al. 2010. journals.plos.org/plosmedicine/article?id=10.1371/journal.pmed.1000262
61 Adair, T. and Lopez, A. 2018. doi.org/10.1371/journal.pone.0197047
62 Schmertmann, C. P. and Gonzaga, M. R. 2018.
63 Queiroz, B.L. and Sawyer, D.O.T. 2012. pophealthmetrics.biomedcentral.com/articles/10.1186/s12963-020-00213-4
64 Vasconcelos, A. M. N. 2000.
65 Waldvogel, B. C. et al. 2008. abep.org.br/publicacoes/index.php/anais/article/view/1754/1714
66 França et al. 2008. academic.oup.com/ije/article/37/4/891/738704
67 Agostinho, C. S. 2009.
68 Agostinho, C. S. and Queiroz, B. L. 2010. abep.org.br/publicacoes/index.php/anais/article/download/1871/1830
69 Lima, E. E. C. and Queiroz, B. L. 2014.
70 Queiroz, B. L. et al. 2017.
71 Lima, E. E. C. and Queiroz, B. L. 2014.
72 Paes, N. A. 2005. scielo.br/scielo.php?pid=S0034-89102005000600003&script=sci_abstract&tlng=pt
73 Agostinho, C. S. 2009.

Photo: Ousmane Traore (MAKAVELI) / World Bank

Results on the evolution of adult death and mortality records coverage in Brazil show notable regional differences in relation to the spatial and temporal evolution of data quality. Results indicate a constant advance in mortality data quality in Brazil. In 2010, almost all states in the south and southeast had complete death records, as shown in the results of Figure 2. Furthermore, there has been a temporal advance in the quality of mortality information in the poorest states in the north and northeast, especially those with the worst quality in the previous period.

For both sexes, the northeast and the north showed greater progress in death record coverage in the last three decades. Regions closest to capital cities had greater coverage throughout the period. Improvements appear to be related to investments in the public health system and administrative procedures to improve the recording of vital events. Thus, the quality of mortality data appears to have improved significantly over the years and in many regions of the country. The analysis suggests that efforts by federal, state, and municipal governments to improve the quality of vital statistics in Brazil are having success and will allow a better understanding of the health and mortality transition dynamics in the country. Continued investment in the Family Health Program may have a significant impact on improving mortality data quality in Brazil, as it works closely with the community and monitors the health status of various individuals at each location.

However, despite improvements in the quality of communicating death records, other issues still persist, such as late registration and the time of availability of death information. These issues can have a greater importance in a pandemic context, such as that of SARS-CoV-2.

Late registration of deaths and time of data availability by official platforms

Despite advances achieved by the death registration system in Brazil, it is important to highlight two relevant issues: late records and time of data availability.

The two death registration systems in Brazil, the civil registry and the MIS, have the same data collection source: the death certificate. The civil registry's death data is collected quarterly by the IBGE from notary offices throughout Brazil. Civil registry offices are responsible for the primary collection, based on a copy of the death certificate requested by the person responsible for the deceased person. Burial should officially occur only after certification that the death was registered in the notary office.

The flow of death records in the MIS, described herein, begins with the death declaration, which occurs in a decentralized manner. The death declaration is filled out by a medical professional, with primary collection under the responsibility of municipal health departments, which then send these to the state health department, which consolidates state deaths and sends them to the Ministry of Health to be entered into the MIS database.

The decentralized nature of mortality data systems is healthy for a country of continental dimensions like Brazil, but there are some delays. According to Oliveira, IBGE provides a computer program for the entry of vital statistics data.[74] Moreover, many registry offices fill in the death data using their own data entry system, so that the collection is practically all computerized. However, 10 percent of establishments, which Oliverira calls *serventias* [service offices], still collect data manually.

To speed up and qualify the process of consolidating death data, Ordinance number 20 of 03/10/2003 laid down protocols for the collection, flow, and periodicity of death data that should be entered into the MIS. In addition, as determined by a resolution of the Ministry of Health, any municipal health department that fails to load the health information systems for two consecutive months will have the transfer of resources suspended.[75] Actions like these have greatly improved the quality of death records in Brazil. However, as we have seen, there are regional differences, and improvements are needed to streamline collection. Late registration is a consequence of the system's decentralization, since not all municipal health departments in the country have the same dynamics, nor are all notaries or agencies, which are responsible for death registries, computerized.

To investigate the absence of registered deaths, the data is evaluated by the Ministry of Health, in addition to an active search program, which has been encouraged by the Ministry of Health, with the objective of recovering unregistered deaths.[76] As a consequence, in July 2020 the last consolidated death database available in MIS was for 2018. In the context of a severe pandemic, it is necessary to use real-time data, and the solution is to use alternative databases.

ALTERNATIVE SOURCES OF DEATH DATA COLLECTION IN A PANDEMIC CONTEXT

ARPEN Transparency Portal (total and COVID deaths)

An alternative source of information on vital statistics that has gained attention and publicity in the country during the pandemic is the Civil Registry Transparency Portal.[77] Accessible since 2018 and maintained by the National Association of Registrars for Individuals (ARPEN), this portal is a publicly available website that provides certain information concerning births, marriages, and deaths. It is not an official source of vital statistics and all information from this source comes from the Civil Registry Information Centre. Collection is made via notary offices and the informant submits a death certificate to the Civil Registry Service Unit responsible for registering the death. In some cases, there is the possibility of a death being registered through a declaration made with a funeral service when death declarations are officially recorded in the region by a municipal funeral service.[78]

Through this platform, it is possible to obtain death information by year, month, and place of occurrence.[79] [80] Information details are summarized by total deaths, with no breakdown

74 Oliveira, A. T. R. 2018. biblioteca.ibge.gov.br/visualizacao/livros/liv101575.pdf

75 Jorge, M. H. Prado de Mello et al. 2007.

76 Szwarcwald, C. L. et al. 2014. ncbi.nlm.nih.gov/pmc/articles/PMC4070625/

77 transparencia.registrocivil.org.br/inicio

78 Chossani, F. W. 2020. arpensp.org.br/index.php?pG=X19leGliZV9ub3RpY2lhcw==&in=OTQzNDc#_ftn2

79 Orellana, J. D. Y. et al. 2020. scielo.br/scielo.php?script=sci_arttext&pid=S0102-311X2020000706001&lng=en&nrm=iso&tlng=en

80 França, E. B. et al. 2020. doi.org/10.1590/1980-549720200053

by sex or age or any information on the underlying cause of death. Death information comes from the municipal level, and mortality information for the current year up to 2015 can be obtained.[81]

In addition to total deaths, the portal provides information on deaths with undefined causes (with a percentage of these deaths recognized upon analysis), separated by sex, skin colour, and approximate age — something that enables studies on incomplete death information.[82] França et al. point out that the civil registry collects information on natural causes of death by place of occurrence, in addition to a delay with major regional differences between the occurrence of the event and the registry.[83]

With regard to information on deaths due to COVID-19, the website also provides information on this cause of death, giving special attention to COVID-19 deaths along with deaths from respiratory and cardiovascular diseases. These causes of death contain greater detail in terms of information, as these are available by municipality (in locations with greater than 50 suspected or confirmed COVID-19 cases), by sex, skin colour, and age. Information on deaths can be obtained daily for the year 2020.[84] It is worth pointing out that although the offer of tests is less than the demand, some death certificates are issued without a prior confirmation of a COVID-19 viral diagnosis.[85] In these cases, it is desirable that medical professionals certifying the death, when they suspect that the respiratory illness is due to COVID-19, state this in the death certificate.[86]

In some cases, such as in the state of São Paulo, guidelines were issued for procedures in issuing death certificates in light of the COVID-19 pandemic.[87] According to these guidelines, all deaths confirmed as COVID-19 must be classified using the International Classification of Diseases ICD code B34.2 (coronavirus infection from an unspecified location). In other cases, when a death confirmed by the doctor mentions "Severe Acute Respiratory Syndrome – SARS," or "Acute Respiratory Disease" due to COVID-19 on the death certificate, it must be classified as ICD-U04.9.

In suspicious cases, without confirmation of infection and awaiting tests, the ideal is that the medical professional certifying the death indicates suspicion of death resulting from COVID-19 on the death certificate. There are cases where the death is registered in a registry office, and the diagnosis for COVID-19 is only confirmed later (not even mentioning the suspicion of COVID-19 as the cause of death). In these cases, it is possible that such information is corrected on the death certificate by means of an annotation.[88] The annotation process must come through the interested party by means of relevant documents issued by competent agencies.

Despite the data limitations, several studies in Brazil have shown the pandemic's effect on excess mortality in mid-2020, mirroring the importance of reliable and publicly available data sources in a timely manner to better prepare health management. Several studies show that in

81 ARPEN 2020. transparencia.registrocivil.org.br/registros

82 Ibid.

83 França, E. B. et al. 2020.

84 Ibid.

85 Chossani, F. W. 2020.

86 Ibid.

87 São Paulo Department of Health. 2020. saude.sp.gov.br/coordenadoria-de-controle-de-doencas/homepage/noticias/orientacoes-para-emissao-de-declaracao-de-obito-frente-a-pandemia-de-covid-19

88 Chossani, F. W. 2020.

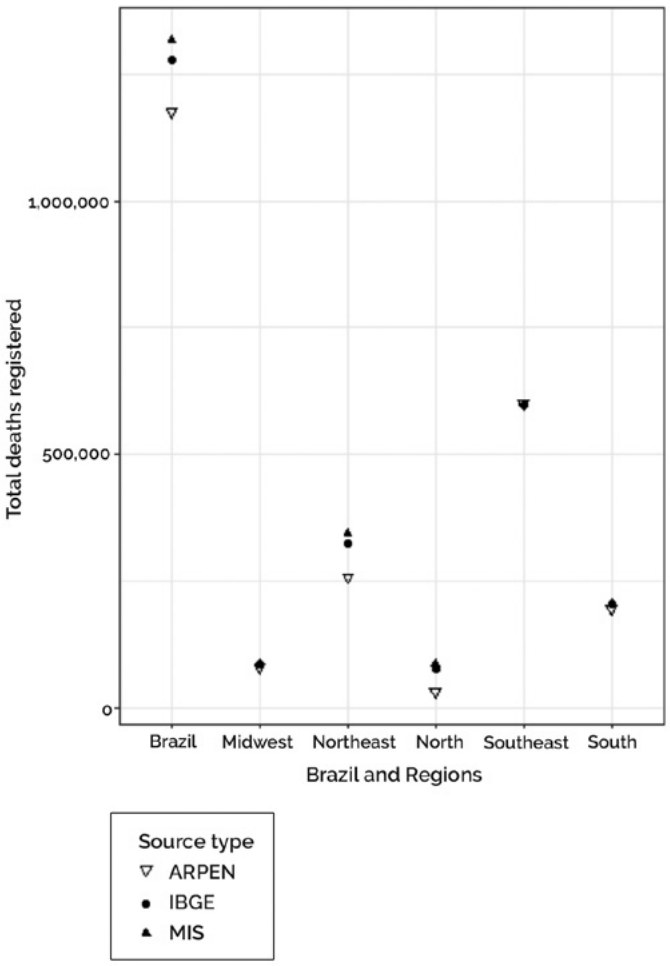
Brazil's largest urban centres, overall mortality in 2020 was much higher than that observed in 2019.[89 90 91] It should be noted that not all excess mortality was due to COVID, but also to other causes that could have been avoided had there been no pressure on the health system. It is also possible that COVID deaths were recorded as other respiratory or ill-defined causes.

The ARPEN data has values close to the other bases in the south and southeast regions, as seen in Figure 3, but this data is more underreported than other sources. MIS data are the best in terms of coverage and accuracy, but the Ministry of Health's process takes longer and data will not be available for analysis in 2020.

The greatest advantage of MIS is that we will have more detailed and adequate information for cause of death. However, as we stressed, this condition only makes analysis more resounding, as the correction and completeness of data will make the excess deaths even more evident. It is also important that the agencies release the data as detailed as possible, by sex, age, and cause of death, so that health managers may monitor the pandemic's potential effect on the general health of the population.

The Ministry of Health also reports mortality data and only confirmed cases of COVID-19 in Brazil. Information is compiled from data sent by state health departments and is released daily by the ministry. Case and death data is updated on the date of notification. Aggregate data is released on the Ministry of Health platform[92] and microdata can be accessed on specific ministry websites.

Figure 3: Total deaths registered in Brazil in 2018. Comparison of various registration sources.



Source: DATASUS-MIS, Civil Registry IBGE, ARPEN, 2018

89 França, E. B. et al. 2020.

90 Freitas, A. R. R. et al. 2020. doi.org/10.1590/SciELOPreprints.442

91 Lima, E. E. C. et al. 2020. doi.org/10.31219/osf.io/xhkp4

92 Coronavirus Brazil. 2021. covid.saude.gov.br/

Data sources focused on deaths and health issues during the pandemic

In addition to the Transparency Portal platform, the IBGE has carried out surveys with the objective of monitoring the increase in the number of deaths due to COVID-19. Thus, on 4 May 2020, collection by the National Household Sample Survey – PNAD COVID-19 began.[93]

The survey is conducted by telephone with a fixed sample of approximately 48,000 households per week and a total of 193,000 households per month, covering the entire country. Households interviewed in the first month remain in the sample for subsequent months until the end of the survey.[94]

The survey questionnaire has a section on health issues, with a focus on symptoms associated with the influenza syndrome. The purpose of this health module is to look into the occurrence of some of the main COVID-19 symptoms during the study reference period, thus taking all household residents into account. For symptomatic patients, further questions are targeted on the measures taken to relieve symptoms, whether they sought medical care, and the type of health facility sought.[95]

The PNAD COVID-19 questionnaire is subject to change over the period of its application and the survey foresees weekly disclosures for some indicators in Brazil, and monthly disclosures by state for a broader set of indicators.[96]

There is also a database called Infogripe, made available by the Oswaldo Cruz Foundation.[97] This is an initiative to monitor hospitalized cases of Severe Acute Respiratory Syndrome (SARS) and reported to the Notifiable Disease Information System. On this basis, it is possible to gather information on cases and deaths due to SARS in general, and due to SARS complications from COVID-19, according to Brazilian state, epidemiological week, sex, and age group.[98] [99]

One group of Brazilian researchers has also organized the collection and dissemination of COVID mortality and case data gathered directly from state health departments. The *Brasil.io – Especial COVID-19* portal organizes data for all states and releases daily information on cases and deaths due to COVID to all municipalities in Brazil.[100] Information at this geographical level is not released on a regular basis by the Ministry of Health. This portal is the only one that makes data available in open format (open data).

Following the same line of state-based information organized on pandemic impacts, the National Council of Health Departments presents mortality data from natural causes (including COVID-19 mortality) for all states in Brazil, along with an estimate of expected deaths for 2020, based on the trend observed between 2015 and 2019. This data allows for the assessment of excess mortality in Brazil in 2020 and is organized by large regions, states, age, and sex. The organization of data from the departments and the analysis of excess mortality allows the

93 IBGE. 2020b. ibge.gov.br/estatisticas/sociais/trabalho/27947-divulgacao-mensal-pnadcovid2.html?=&t=o-que-e

94 Ibid.

95 Ibid.

96 Ibid.

97 Oswaldo Cruz Foundation. 2020. info.gripe.fiocruz.br

98 Lana, R. M. et al. 2020. scielo.br/scielo.php?script=sci_arttext&pid=S0102-311X2020000300301

99 Zuvanov, A. S. et al. 2020. ipea.gov.br/portal/index.php?option=com_content&view=article&id=35643

100 Brasil.io. 2021. brasil.io/home/

assessment of the pandemic's impacts in Brazil and other regions.[101]

DISCUSSION

In this paper, we briefly introduced the two main sources of mortality information in Brazil: statistics and civil records from the Ministry of Health and the IBGE. We highlighted its origin, form of collection, main problems in terms of information quality, and finally, alternative sources that are emerging in the country during the context of the COVID-19 pandemic. Here we highlighted data from the National Association of Registrars for Individuals (ARPEN), which uses registry office death information, as well as the IBGE. Underreporting cases and delays in this latter database are apparently greater than the other two official sources studied.[102]

Despite this, the ARPEN database, as well as other information sources (such as PNAD COVID-19), have proved to be important providers of vital statistics information in assisting research and health managers, especially in the stressful scenario caused by the pandemic. It is essential that this source of information be made official, similar to data from the IBGE and Ministry of Health, and be very restricted to the context of the COVID-19 pandemic. For example, using the ARPEN database, we can highlight some studies that demonstrated how overall mortality in Brazil during the first months of the 2020 pandemic was much higher than that observed in 2019.[103] [104] [105] [106]

It is also important to note that delays in sending death information through registry offices can occur (or even increase in the pandemic context). This is a commonly observed fact in some Latin American countries.[107]

The existence of ARPEN data allows health managers in Brazil to better analyze the impact of the pandemic on population health and mortality. The data is constantly updated and publicly available. In other countries, the same scenario does not take place. Adjiwanou et al. point out that various middle- and low-income countries have major limitations in collecting adequate information about the pandemic's impacts.[108] In general, these countries already have limited or very precarious civil registry systems, and the social and economic impacts of the pandemic further aggravate the situation.[109] Adjiwanou et al. argue that few developing countries have adequate oversight systems in place to collect mortality information from individuals who have not been tested for COVID or deaths that occur outside of hospitals, making it impossible to adequately measure excess mortality.[110] As such, they suggest collecting information via mobile phone surveys, which already exist in a wide range of countries and could include issues related to mortality and health in general due to COVID. One of the advantages of this approach is that there are already consolidated techniques for including pertinent questions and performing data analysis.

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101 conass.org.br/indicadores-de-obitos-por-causas-naturais/

102 França, E. B. et al. 2020.

103 Ibid.

104 Freitas, A. R. R. et al. 2020.

105 Lima, E. E. C. et al. 2020.

106 Marinho, F. et al. 2020. vitalstrategies.org/excess-mortality-in-brazil-a-detailed-description-of-trends-in-mortality-during-the-covid-19-pandemic/

107 Gutierrez, E. et al. 2020. cepr.org/content/covid-economics-vetted-and-real-time-papers-0#block-block-9

108 Adjiwanou, V. et al. 2020.

109 Nsubuga, P. et al. 2010. pubmed.ncbi.nlm.nih.gov/21143827/

110 Adjiwanou, V. et al. 2020.

In the case of Brazil, the Ministry of Health has developed a mobile application that contains general health information for users of the system and that now, together with Google and Apple, will adopt an exposure notification system that grants the user information on people contacted who tested positive for COVID in the past two weeks.[111] The idea is that the system works as a means for tracking and contacting positive cases, and for controlling new outbreaks. The information will be entered into the system in a confidential and secure way for users.

Concerning the civil registry system in a broader sense, health and development challenges in the coming decades cannot be effectively addressed without reliable data on births, deaths, and causes of death, which only a comprehensive civil registration and statistics system can offer.[112]

Even with the significant improvements in death information collection and accuracy in Brazil during the last 40 years,[113] [114] [115] [116] it is still necessary to develop research that presents and demonstrates evidence on which strategies for collecting civil records and statistics work best and in which contexts. This is all to ensure that the potential benefits of this data are successfully enhanced. Furthermore, collection results need to be compiled and made available promptly and publicly to users and managers for policy, programming, and reference,[117] something that is still problematic in the Brazilian scenario and has worsened during the COVID-19 pandemic.

A recurring problem that compromises the speed of epidemiological and demographic studies, besides health actions and policies, is related to the time of dissemination of MIS data. A good practice that could be adopted by the Ministry of Health would be to create a dual flow of information delivery in which there would be (1) unverified and uncorrected death data made available immediately to health managers and researchers, and (2) death data made available later, after analysis of the information quality.

In addition to the time of availability, another practice that could have a positive impact on death data quality would be an investment on the part of state governments to align information from the two official sources, MIS and the civil registry of the IBGE. This practice was implemented in the state of São Paulo[118] and has had a positive impact on the quality of death information, as well as other vital statistics in this state.

Everton E. C. Lima, Marcos R. Gonzaga, Flávio H. M. de A. Freire, and Bernardo L. Queiroz

111 Ministry of Health. 2020a. datasus.saude.gov.br/aplicativo-coronavirus-sus-vai-alertar-contatos-proximos-de-pacientes-com-covid-19/

112 AbouZahr, C. et al. 2015. pubmed.ncbi.nlm.nih.gov/25971224/

113 Paes, N. A. 2005.

114 Agostinho, C. S. 2009.

115 Lima, E. E. C. and Queiroz, B. L. 2014.

116 Ibid.

117 AbouZahr, C. et al. 2015.

118 Waldvogel, B.C. et al. 2008.

BIBLIOGRAPHY

AbouZahr, C. et al. 2015. Civil registration and vital statistics: progress in the data revolution for counting and accountability. *The Lancet* 386. 10001: 1373-1385. doi.org/10.1016/S0140-6736(15)60173-8

Adair, T. and Lopez, D. 2018. Estimating the completeness of death registration: An empirical method. *PloS one*. 13.5. e0197047. journals.plos.org/plosone/article?id=10.1371/journal.pone.0197047

Adjiwanou, V. et al. 2020. Measuring Excess Mortality During the COVID-19 Pandemic in Low- and Lower-Middle Income Countries: The Need for Mobile Phone Surveys. *SocArXiv.* doi.org/10.31235/osf.io/4bu3q

Agostinho, C. S. 2009. Estudo sobre a mortalidade adulta, para Brasil entre 1980 e 2000 e unidades da Federação em 2000: uma aplicação dos métodos de distribuição de mortes. Doctoral thesis. Cedeplar/UFMG. cedeplar.ufmg.br/publicacoes/teses-e-dissertacoes/teses-demografia/category/130-2009

Agostinho, C. S. and Queiroz, B. L. 2010. Estimativas da mortalidade adulta para o Brasil no período 1980/2000: uma abordagem metodológica comparativa. Anais do Encontro de Estudos Populacionais da ABEP. 1–2. abep.org.br/publicacoes/index.php/anais/article/download/1871/1830

ARPEN (National Association of Registrars for Individuals). 2020. Transparency Portal Civil Registry. transparencia.registrocivil.org.br/registros

Baldijão, M. F. A. 1992. Health Information Systems. *São Paulo in Perspective*, 6(4), 21–28. produtos.seade.gov.br/produtos/spp/v06n04/v06n04_04.pdf

Brasil.io. 2021. brasil.io/home/

Chossani, F. W. 2020. Death Records in Covid-19 Times. arpensp.org.br/index.php?pG=X19leGliZV9ub3RpY2lhcw==&in=OTQzNDc#_ftn2

Coronavirus Brazil. 2021. covid.saude.gov.br/

Cunha, C. C. D. et al. 2017. Assessment on the Investigation of Deaths in Brazil from Ill-Defined Causes in 2010. *Epidemiology and Health Services*, 26, 19–30. scielo.br/scielo.php?script=sci_arttext&pid=S2237-96222017000100019&lng=en&nrm=iso&tlng=en

DATASUS (Brazilian Unified Health System Informatics Department). 2020. datasus.saude.gov.br/

França, E. B. et al. 2008. Evaluation of cause-of-death statistics for Brazil, 2002–2004. *International Journal of Epidemiology*, 37(4), 891–901. academic.oup.com/ije/article/37/4/891/738704

França, E. B. et al. 2014. Evaluation of the Implementation of the 'Reduction of the Percentage of Ill-defined Deaths' Program in One Northeastern State of Brazil. *Brazilian Journal of Epidemiology*, 17(1), 119–134.

França, E. B. et al. 2020. Deaths Due to COVID-19 in Brazil: How Many Are There and Which Are Being Identified? *Brazilian Journal of Epidemiology*, 23, E200053. doi.org/10.1590/1980-549720200053

Freitas, A. R. R. et al. 2020. Use of Excess Mortality Associated with the COVID-19 Epidemic as an Epidemiological Surveillance Strategy: Preliminary Results of the Evaluation of Six Brazilian Capital Cities. Preprinted in SciELO – Scientific Electronic Library Online. doi.org/10.1590/SciELOPreprints.442

Gutierrez, E. et al. 2020. Delays in Death Reports and their Implications for Tracking the Evolution of COVID-19. SSRN 3645304. cepr.org/content/covid-economics-vetted-and-real-time-papers-0#block-block-9

Hill, K. et al. 2009. Death Distribution Methods for Estimating Adult Mortality: Sensitivity Analysis with Simulated Data Errors. *Demographic Research*, 21, 235–254. demographic-research.org/volumes/vol21/9/default.htm

IBGE (Brazilian Institute of Geography and Statistics). 2020a. Population: Civil Registry Statistics. ces.ibge.gov.br/apresentacao/portarias/200-comite-de-estatisticas-sociais/base-de-dados/1148-estatisticas-do-registro-civil.html

IBGE (Brazilian Institute of Geography and Statistics). 2020b. National Household Sample Survey PNAD COVID-19. ibge.gov.br/estatisticas/sociais/trabalho/27947-divulgacao-mensal-pnadcovid2.html?=&t=o-que-e

Jorge, M. H. Prado de Mello et al. 2007. Quality analysis of Brazilian vital statistics: the experience of implementing the SIM and SINASC systems. *Collective Science & Health*, 12(3), 643–654. pubmed.ncbi.nlm.nih.gov/17680121/

Kanso, S. Romero et al. 2011. Geographic, Socioeconomic, and Demographic Differentials in the Quality of Information on the Basic Cause of Death of the Elderly in Brazil. *Public Health Notebooks*, 27(7). pubmed.ncbi.nlm.nih.gov/21808817/

Lana, R. M. et al. 2020. The novel coronavirus (SARS-CoV-2) emergency and the role of timely and effective national health surveillance. *Cadernos de saude publica*, 36, e00019620. scielosp.org/article/csp/2020.v36n3/e00019620/en/

Leon, D.A. et al. 2020. COVID-19: A need for real-time monitoring of weekly excess deaths. *The Lancet*. Vol. 395(10234):e81. thelancet.com/journals/lancet/article/PIIS0140-6736(20)30933-8/fulltext

Lima, E. E. C. and Queiroz, B. L. 2014. Evolution of the Death Registry System in Brazil: Associations with Changes in the Mortality Profile, Under-registration of Death Counts, and Ill-Defined Causes of Death. *Public Health Notebooks*, 30(8), 1721–1730. scielo.br/scielo.php?script=sci_arttext&pid=S0102-311X2014000801721

Lima, E. E. C. et al. 2020. Exploring Excess of Deaths in the Context of the Covid Pandemic in Selected Countries of Latin America. *OSF Preprints*. doi.org/10.31219/osf.io/xhkp4

Luy, M. 2012. Estimating Mortality Differences in Developed Countries from Survey Information on Maternal and Paternal Orphanhood. *Demography*, 49(2), 607–627. link.springer.com/article/10.1007/s13524-012-0101-4

Marinho, F. et al. 2020. Excess Mortality in Brazil: A Detailed Description of Trends in Mortality During the Covid-19 Pandemic. Technical Note. vitalstrategies.org/excess-mortality-in-brazil-a-detailed-description-of-trends-in-mortality-during-the-covid-19-pandemic/

Mikkelsen, L. et al. 2015. A Global Assessment of Civil Registration and Vital Statistics Systems: Monitoring Data Quality and Progress. *The Lancet,* October 3, 386(10001), 1395–1406. thelancet.com/journals/lancet/article/PIIS0140-6736(15)60171-4/fulltext

Ministry of Health. 2009. Death Certificates Necessary and Important Documents. portalarquivos2.saude.gov.br/images/pdf/2015/agosto/14/Declaracao-de-Obito-WEB.pdf

Ministry of Health. 2020a. Coronavirus-SUS Application to Alert Close Contact with Covid-19 Patients. datasus.saude.gov.br/aplicativo-coronavirus-sus-vai-alertar-contatos-proximos-de-pacientes-com-covid-19/

Ministry of Health. 2020b. Mortality Information System (MIS). opendatasus.saude.gov.br/dataset/casos-nacionais.

Murray, C. J. L. et al. 2010. What Can We Conclude from Death Registration? Improved Methods for Evaluating Completeness. *PLoS Med,* 7(4), e1000262. journals.plos.org/plosmedicine/article?id=10.1371/journal.pmed.1000262

Nsubuga, P. et al. 2010. Strengthening Public Health Surveillance and Response Using the Health Systems Strengthening Agenda in Developing Countries. *BMC Public Health*, 10(1), S5. pubmed.ncbi.nlm.nih.gov/21143827/

Oliveira, A. T. R. 2018. Vital Statistics Systems in Brazil: Advances, Perspectives, and Challenges. IBGE. biblioteca.ibge.gov.br/visualizacao/livros/liv101575.pdf

Oliveira, L. A. P. D. and Simões, C. C. D. S. 2005. O IBGE e as pesquisas populacionais. Revista Brasileira de Estudos de População, 22(2), 291-302. doi.org/10.1590/S0102-30982005000200007

Orellana, J. D. Y. et al. 2020. Explosão da mortalidade no epicentro amazônico da epidemia de COVID-19. Cadernos de Saúde Pública, 36, e00120020. doi.org/10.1590/0102-311x00120020

Oswaldo Cruz Foundation. 2020. Monitoring of reported hospitalized cases of severe acute respiratory syndrome (SARS). info.gripe.fiocruz.br

Paes, N. A. and Albuquerque, M. E. E. 1999. Evaluation of the quality of population data and death record coverage for Brazilian regions. *Journal of Public Health*, 33 (1), 3343.

Paes, N. A. 2005. Avaliação da cobertura dos registros de óbitos dos estados brasileiros em 2000. Revista de SaúdePública, 39, 882–890.

Presidência da República. 1997. Presidência da República Casa Civil. Subchefia para Assuntos Jurídicos. planalto.gov.br/ccivil_03/leis/l9534.htm

Queiroz, B. L. et al. 2017. Completeness of death-count coverage and adult mortality (45q15) for Brazilian states from 1980 to 2010. *Brazilian Journal of Epidemiology*, 20(Suppl. 1), 21–33. scielo.br/scielo.php?pid=S1415-790X2017000500021&script=sci_arttext&tlng=en

Queiroz, B. L. et al. 2020. Comparative analysis of completeness of death registration, adult mortality and life expectancy at birth in Brazil at the subnational level. *Population Health Metrics*, 18(11). pophealthmetrics.biomedcentral.com/articles/10.1186/s12963-020-00213-4

Queiroz, B. L. and Sawyer, D. O. T. 2012. What Can the Mortality Data from the 2010 Census Tell Us? *Brazilian Journal of Population Studies*, 29(2), 225–238. pophealthmetrics.biomedcentral.com/articles/10.1186/s12963-020-00213-4

Rao, C. 2020. Medical Certification of Cause of Death for COVID-19. *Bulletin of the World Health Organization*, 98(5), 298. who.int/bulletin/volumes/98/5/20-257600/en/

São Paulo Department of Health. 2020. Guidelines for Issuing Death Certificates in View of the COVID-19 Pandemic. saude.sp.gov.br/coordenadoria-de-controle-de-doencas/homepage/noticias/orientacoes-para-emissao-de-declaracao-de-obito-frente-a-pandemia-de-covid-19

Schmertmann, C. P. and Gonzaga, M. R. 2018. Bayesian Estimation of Age-Specific Mortality and Life Expectancy for Small Areas with Defective Vital Records. *Demography*, 55(4), 1363–1388. link.springer.com/article/10.1007/s13524-018-0695-2

Senra, N. 2006. *History of Brazilian Statistics: Desired Statistics (1822c. 1889)*. Vol. 1. Ministry of Planning, Budget, and Management. biblioteca.ibge.gov.br/index.php/biblioteca-catalogo?id=282656&view=detalhes

Senra, N. 2008. Historical Survey of Statistics: Themes and Sources. *History, Sciences, Health – Manguinhos*, 15(2), 411–425. scielo.br/scielo.php?script=sci_arttext&pid=S0104-59702008000200011&lng=pt&tlng=pt

SIDRA. 2020. IBGE Automatic Recovery System. sidra.ibge.gov.br/

Szwarcwald, C. L. et al. 2014. Correction of vital statistics based on a proactive search of deaths and live births: evidence from a study of the North and Northeast regions of Brazil. *Population Health Metrics*, 12:16. ncbi.nlm.nih.gov/pmc/articles/PMC4070625/

United Nations Department of Economic and Social Affairs (UN DESA). 2017. Analytical Methods to Evaluate the Completeness and Quality of Death Registration: Current State of Knowledge. UN Technical Paper No. 2017/2. un.org/development/desa/pd/fr/node/2802

Vasconcelos, A. M. N. 1998. The Quality of Death Statistics in Brazil. *Brazilian Journal of Population Studies*, 15(1). rebep.org.br/revista/article/view/416

Vasconcelos, A. M. N. 2000. Quality of Death Statistics in Brazil: Breakdown by State. XII National Meeting of Population Studies, ABEP Annals. Caxambú-MG.

Waldvogel, B. C. and de Carvalho Ferreira, C. E. 2003. Life Statistics. *São Paulo in Perspective*, 17.3-4, 55–66. produtos.seade.gov.br/produtos/spp/v17n03-04/v17n03-04_06.pdf

Waldvogel, B. C. et al. 2008. State of São Paulo Unified Birth and Death Database: An Instrument to Improve Health Indicators. XVI National Meeting of Population Studies, ABEP. Caxambú- MG. abep.org.br/publicacoes/index.php/anais/article/view/1754/1714

Zuvanov, A. S. et al. 2020. Data Sources for Covid-19 Studies. IPEA Technical Note No. 10.

All references with Portuguese titles are available only in Portuguese.

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